Unfunded pension liabilities and sponsoring firm credit risk

Unfunded pension liabilities and sponsoring firm credit risk: An international analysis of corporate bond spreads

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This paper tests empirically whether pension information derived by corporate pension accounting disclosures is priced in corporate bond spreads. The model represents a hybrid of more traditional accounting ratio-based models of credit risk and structural models of bond spreads initiated by Merton (1974). The model is fitted to 5 years of data from 2002 to 2006 featuring companies from the US and Europe. The paper finds that while unfunded pension liabilities are priced in the overall sample, they are not priced as aggressively as traditional leverage. Furthermore, an extended model shows that the pension–credit risk relation is most evident in the US and Germany, where unfunded pension liabilities are priced more aggressively than traditional forms of leverage. No pension–credit risk relation is found in the other countries sampled, notably the UK, Netherlands and France.

Keywords: defined benefit pension scheme; pension funding; credit risk; corporate bond spreads

1. Introduction

The 'perfect storm'[1] of negative equity returns and low interest rates in the early years of this millennium has resulted in the majority of defined benefit pension schemes experiencing a deficit, whereby the liabilities of the scheme exceed the assets. In a defined benefit pension scheme, the benefit the members receive from the scheme is defined ex-ante. The scheme sponsor promises to pay a pension based on this defined benefit, whatever may be the size of the fund backing this promise. The plan sponsor typically makes all the decisions and is responsible for the funding adequacy of the plan. The sponsor bears the liability for future payments to retirees and assumes the risk if the fund under-performs or fails. By 2002, unfunded pension liabilities had become widespread throughout Europe and the US. In 2002, on average, firms were reporting a funding deficit of €733 million, €533 million in 2003, €531 million in 2004, €556 million in 2005 and €337 million in 2006.[2] Commentators argue that the prevalence of underfunding stems from unsustainable improvements to defined benefit obligations over the past 50 years, which were made without appropriate assessment and acknowledgement of the inherent shortcomings in the defined benefit pensions framework.

The relationship between the firm and its pension plan has been debated in the literature with two primary schools of thought emerging. One is the traditional approach which argues that there is a legal separation between the firm and the pension fund and this implies that funding positions should be based on the future stream of employee pension liabilities, while the asset allocation should be made solely in the best interests of the beneficiaries. The alternative view, the corporate financial perspective, is favoured by economists and implies that defined benefit liabilities are just one more of a set of financial liabilities of the firm. As such the firm's pension deficit/surplus belongs to its shareholders and the company will choose the structure of its assets and liabilities to maximize the value to shareholders. The corporate financial view explicitly ignores the interests of scheme beneficiaries.

Consensus of opinion points to a general acceptance of the corporate financial perspective. The implication of this is that pension risk should be reflected in bond spreads and if so the debt market can be viewed as informationally efficient with regard to pension disclosures. This, however, may fail to recognize informational frictions. Clark and Monk (2007a, 2007b) identify three particular shortcomings, which contributed to the pension crisis. First, it is generally accepted that in the area of pension accounting, financial reporting has, at least in the past, been somewhat opaque. This led to extensive reform to accounting practices internationally, namely, FRS17, IAS19 and FAS158.
Several studies have demonstrated that more transparent accounting standards negatively impact upon the valuation of those companies running pension plan deficits(e.g. Zion and Carache 2002; Franzoni and Marin 2006). Second, the lack of consistency of actuarial assumptions is utilized in the calculation of pension plan funding. Punter Southall (2007) reveal significant variability in actuarial assumptions pertaining to the discount rate, inflation rate, salary increases, return on equity and mortality rates. Third, the role of a pension benefit guarantee fund, as guarantor of pension benefits, may cloud the relationship between the risk of the pension plan and the market risk.3

Set against the backdrop of informational frictions, the present study explores whether corporate pension accounting disclosures with respect to defined benefit pension schemes are priced in corporate bond spreads. The analysis is undertaken for firms whose bonds are constituents of the IBOXX European Corporate Bond Index4 and estimated in a panel framework for the 2002–2006 period. Our analysis reveals that, in general, pension risk is priced in corporate spreads and lends support to the view that debt markets are informationally efficient with regard to pension disclosures. There is, however, some cross country variation in the findings with some evidence of a break in our general findings for the UK, the Netherlands and France.

The remainder of the paper is structured as follows. In Section 2, we explore the theoretical and empirical literature examining the relationship between the pension plan and the firm. Section 3 identifies the sources of data used in the study and defines the variables used. This is followed in Section 4 by an outline of the model specifications fitted to the data and in Section 5 by the empirical results and their discussion. Finally, Section 6 concludes.

2. Literature

In this section, we consider literature that explores the theoretical and empirical relationships between the defined benefit pension scheme and the firm. The theoretical foundations in the literature have been examined empirically with reference to both corporate debt and equity. Although the relationship between the pension scheme and the firm equity is not part of our empirical investigation, we will consider some of the key papers in this area as they offer tangential insight into the pension scheme—corporate debt relationship.

2.1 *Two theoretical schools of thought*

There are two theoretical schools of thought on whether pension risk impacts upon firm risk: the traditional approach and the corporate financial approach. The former asserts that there is generally a legal separation between the company and its pension fund and therefore the fund should be managed without regard to the corporate financial policy or the interests of the shareholders. From this traditional stance, it is implied that funding positions should be based on the future stream of employee pension liabilities, while the asset allocation should be made solely in the best interests of the beneficiaries. However, consensus on the asset allocation that is best for beneficiaries is often unclear. If the scheme is set-up in such a way that beneficiaries cannot share any surplus of pension assets over liabilities, they are likely to prefer a well funded plan to be invested in the least risky assets, in all likelihood fixed income securities. On the other hand, if beneficiaries are allowed to share the surplus, as documented by Miller and Scholes (1981), Bulow and Scholes (1982) and Carroll and Niehaus (1998), then virtually any asset mix can be justified and the optimal asset allocation becomes unclear.

In contrast, the corporate financial perspective implies that defined benefit liabilities are just one more of a set of financial liabilities of the firm. Black (2006) states that "because pension benefits are normally independent of fund performance, pension assets impact the firm very much as if they were firm assets". In essence, the firm's pension deficit/surplus belongs to its shareholders and the company will chose the structure of its assets and liabilities to maximize the value to shareholders. The corporate financial perspective is now generally accepted both theoretically and empirically, see, for example, the early works of Tepper (1981), Bodie et al (1986), Black (2006) and later studies by Cardinale (2006) and Jin, Merton, and Bodie (2006).

In the corporate financial perspective, the interests of scheme beneficiaries are considered to be protected by the government and a key tool of corporate financial policy is the game between the corporations and the various government agencies that ultimately decides the outcome of corporate pension decisions. Bodie et al. (1986) subdivide this game into three core areas, namely: the tax shelter effect; the financial slack effect and pension optionalities. The tax shelter property arises from the fact the firm is able to borrow the after-tax rate of interest, while the pension fund is able to earn the pre-tax rate of interest. Therefore, it is more advantageous for the company to borrow and transfer the proceeds to the pension fund to invest in bonds.[5] The financial slack effect is closely linked to the tax shelter effect and centres upon the fact that the managers are likely to have better information about a firm's prospects than outsiders. Consequently, the managers have an incentive to issue stock when they believe it is overpriced and knowing this the investors react negatively to a stock issue. It is therefore desirable for the managers to maintain some financial slack to avoid a stock issue. Typically, this slack can be held as liquid assets, unused debt capacity or pension assets, while the latter is much more advantageous for tax purposes. Finally, pension optionality research focuses on the presence of pension benefit guarantee schemes, which underwrite a sponsor's pension promise. This essentially creates a put option (see Sharpe 1976; Treynor 1977) for the firm and correspondingly an incentive for corporate managers to maximise the value of this put option and consequently shareholder value by investing in the riskiest equities.[6]

So far we have focused on two extremes in terms of how the scheme is managed with respect to the interests of the beneficiaries and shareholders. For example, at one extreme, we have the corporate financial perspective which implies that the scheme management should explicitly ignore the interests of beneficiaries. However, in many countries pension regulation requires scheme trustees who take strong independent steps to protect the interests of the scheme beneficiaries. Trustees need to perform regular reviews (Employer Covenant Reviews) of the financial strength of the sponsoring employer to ensure that it can meet its obligations to the scheme. This clearly enforces a compromise under which the scheme must be managed in the interests of both beneficiaries and shareholders.

2.2 *The pension fund and corporate equity*

There is a substantial literature in economics and finance studying 'value transparency' or whether pension assets and liabilities affect the market valuation of firms. One of the earlier studies in this area was conducted by Feldstein and Seligman (1981). They found that the growth of unfunded pension liabilities is a key contributor for the poor performance of share prices relative to book values and earnings. A more sophisticated paper by Feldstein and Morck (1985) utilizing homogeneity of interest rate assumptions finds that the market appears to see through the 'pension accounting veil' and sets market values that are more closely related to a pension obligation valued at a standard common interest rate rather than the pension obligations reported by firms. Bulow, Morck, and Summers (1987) support these earlier findings and report that 'the stock market valuation of firms reasonably reflects their pension funding situations'.

Given the perfect storm and corresponding pensions' crisis that emerged from 2000 onwards, Jin, Merton, and Bodie (2006) examined whether the systematic equity risk of US firms as measured by beta from the Capital Asset Pricing Model (CAPM) reflects the risk of their pension plan.

By using data on circa 4500 US companies over the years 1993–1998 and controlling firm-specific risk factors and fixed effects at the industry level, the authors find that equity betas of firms do appear to accurately reflect the betas of their pension assets and liabilities, which are consistent with efficient capital markets.

Franzoni and Marin (2006) examine pension plan funding and market efficiency and find that the market significantly overvalues firms with severely underfunded pension plans. The evidence presented reveals that companies earn lower raw and risk-adjusted stock returns than firms with healthier pension plans for at least 5 years after the first emergence of the underfunding.
The lower returns are reasoned by the authors to be due to the fact that investors are systematically surprised by the negative impact of the pension underfunding on earnings and cash flows.

Given the highly complex nature of pension accounting, a significant tranche of the literature is devoted to the relationship between differing pension accounting standards and the market valuation of unfunded pension liabilities. Coronado and Sharpe (2003) contend that accounting earnings and costs associated with pension plans are often a very misleading measure of the underlying value of net pension obligations; the implication being that the stocks of a number of S&P500 firms, who sponsor defined benefit schemes, were overvalued over the sample period 1993–2001. The authors state that pension information contained in the footnotes to accounts is frequently overlooked in equity valuation. Research conducted by Coronado et al. (2008) focuses on the period 2002–2005, when huge variations in pension valuations encouraged increased scrutiny from analysts and policyholders. Despite this heightened attention they conclude that the equity values of defined benefit sponsoring companies continue to inadequately reflect the true economic value of pension assets and liabilities. Instead, company valuations appear unduly influenced by the accrual reported on the company income statement, while placing little emphasis on the incremental information reported in the footnotes. Although in aggregate the errors estimated are not large they can be significant for individual companies. They suggest that ongoing financial accounting standards reform will result in the migration of key footnote information to the balance sheet. Picconi (2006) arrives at a similarly pessimistic conclusion regarding the ability of investors and analysts to fully process the information available under Statement of
Financial Accounting Standards (SFAS)87, suggesting that both analysts and the equity market only gradually reflect the pension plan information which exert a quantifiable impact upon future (year-ahead) earnings.

2.3 *The pension fund and corporate debt*

There is less literature examining the impact of corporate pension funding on credit ratings. Martin and Henderson (1983) examine the impact of the US Employee Retirement Income Security Act (ERISA) pension risk ratios on bond ratings. They examine a sample of 129 bonds over the period

1979–1980 and find that in addition to the classic predictors of credit risk (return on investment, leverage and times interest earned), the ERISA pension risk ratios, such as unfunded past service costs per employee and pension-related debt to stockholder equity, add significant value to the prediction of corporate credit ratings with the prediction improvement being greater for those bonds with the lowest ratings.

Maher (1987) presents an analysis of the key determinants of bond ratings based on bonds taken from the S&P corporate bond guide over the period 1980–1982. The author finds that the actual pension numbers required to be disclosed by the prevailing accounting standard at the time (SFAS no. 36) were not a significant determinant of the bond rating in any of the years studied. However, when these numbers were discounted at standardized interest rates several proved highly significant. The author also finds differential significance of the pension variable for companies running plan deficits rather than surpluses. The research suggests that a pension deficit is considered to be a corporate liability, while a pension surplus is not considered to be a corporate asset with regard to impacting upon corporate bond ratings.

This asymmetry has also been a feature of subsequent research, such as the work of Carroll and Niehaus (1998). These authors use data over the period 1987–1994 from industrial firms on Compustat Annual Industrial files. They implement an ordered probit model of debt ratings controlling the non-pension plan-related risk variables and the evidence presented indicates that excess pension assets and unfunded pension liabilities influence debt ratings. Moreover, the paper reveals that unfunded pension liabilities decrease debt ratings more than what an equivalent amount of excess pension assets increase debt ratings, ceteris paribus. This asymmetric relationship is consistent with the view that unfunded pension liabilities are corporate liabilities that compete with debt claims, but there are costs associated with quickly accessing excess pension assets.7

The impact of pension plan funding on credit ratings became a more pertinent issue in light of the increasing occurrence of underfunding that emanated from the 'perfect storm'in the early years of the millennium. Rating agencies came under pressure to issue ratings methodology updates clarifying the impact of plan funding on the ratings that they produced. Correspondingly, Moody's and Standard and Poor's released updates in January 2003 and October 2004, respectively. Referring to the actions of the rating agencies, the 2004 International Monetary Fund (IMF) Global
Financial Stability Report states:

"Rating agencies now explicitly recognise the underfunded amount of pension plans as debt of the sponsor company. The rating agencies treat the difference between the PBO (Projected Benefit Obligation) and the fair value of plan assets like any other long-term obligation of the sponsor company."

Watson Wyatt Worldwide (2005) examine the relationship between pension plan funding, credit ratings and funding strategies. Using data from Fortune 1000 pension sponsors over 2002–

2004, they find a notable positive relationship between higher pension deficits and lower credit ratings.

In particular, they note that firms ratedAA have gained significantly more ground on their pension plans' funding positions over the sample period than firms with lower ratings.

An alternative indicator of risk in the debt markets is the spread on corporate debt, also known as credit spread. Cardinale (2006) presents an analysis of defined benefit pension plan funding on credit spreads. US data is taken from the financials and pension plan fundamentals of Fortune 1000 companies with a defined benefit plan according to theWatsonWyatt Financial Accounting Standard (FAS) Survey over the period 2001–2004. UK data is taken from the Watson Wyatt Pension Finance Database of FTSE 350 UK companies over the same period. These fundamentals and pension plan data are matched with corporate spreads from Merrill Lynch Global Bond Index.

The report finds that theUSbond market prices both absolute defined benefit liabilities and pension deficits. Furthermore, the US bond market prices deficits three times as aggressively as ordinary leverage. In the UK, the bond market processes pension information differently. Rather than pricing the pension deficit, the market prices absolute defined benefit liabilities.

3. Sample determination

The dataset thatwas used is taken from a combination of accounting and market sources. Bond data was taken from the IBOXX European Corporate Bond Index, supplemented with option adjusted spread data cross-referenced by bond ISIN from the Merrill Lynch EMU Corporate Index. All bonds in the sample were issued in Euro. Quite often, the name of the issuer proved ambiguous due to the presence of financing vehicles established as part of a firm's structured debt management.

In such cases, each bond was matched to an ultimate issuer by searching for the issuance note for each ISIN, which was sometimes available on the company's websites or otherwise on the exchange websites. For each ultimate issuer, a Thomson entity key was generated. This entity key was then used to download all relevant company accounting data, including pension data, from Thomson One Banker'sWorldscope. The sample data was structured in the form of an unbalanced panel for the period 2002–2006 resulting in 1907 observations. The nature of the unbalanced panel stemmed from improvements to pension accounting disclosure over the sample period resulting in more observations post 2003 (see Table 1). Also highlighted in Table 1 are the countries of origin of the bond issuers with their distribution being a feature of the underlying bond index. Table 1 reveals the dominance of the Netherlands, the US, the UK, France and Germany.

The hypothesis to be tested is that a higher pension plan risk translates into higher credit risk ceteris paribus. This therefore raises a question as to the measurement of the dependent variable.

We have chosen to use the option adjusted spread (OAS) on corporate bonds as our measure of credit risk. The OAS is a flat spread over the treasury yield curve required to discount a security's payments to match its market price. All embedded optionality features (e.g. call, put or sinking funds) are therefore stripped out to ensure model consistency. The advantage of using spreads over credit ratings is the use of a market determined continuous variable as opposed to discrete rating categories. Summary information (the mean, median, quartile and standard deviation) of the credit risk measure is detailed in Table 2. The average OAS is 55 bp with a standard deviation of 34 bp. In Table 2, we present the natural log of the OAS as our specification is log linear.

The key independent variable is that of pension plan risk.We detail four alternative measures based on balance sheet variables. The use of the balance sheet information is consistent with the WatsonWyatt pension risk index and the work, among others, of Carroll and Niehaus (1998) and Jin, Merton, and Bodie (2006). The alternate measures we use are defined as: (i) projected benefit obligation⁄total assets; (ii) projected benefit obligation⁄total debt; (iii) pension deficit⁄shareholder equity and (iv) pension deficit⁄total assets. These measures will hitherto be referred to as BS1 to BS4, respectively. Summary information on these alternate measures is provided in Table 2.

From this table we can see that the average firm has pension liabilities amounting to 11.36% of their total assets and a pension deficit of 2.9% of their total assets.

As will be explained in the next section, the model specification is a hybrid of traditional and structural models of credit risk. As a consequence, a selected number of control variables is additionally introduced into the model specifications. Traditional models propose variables such as short-term financial leverage (short-term debt⁄total assets: STLEV), long-term financial leverage (long-term debt⁄total assets: LTLEV), growth rate (log [total assets⁄lagged total assets]: GR), return on investment (net income⁄total assets: ROI) and firm size (log [total assets]: FS). Structural models also suggest the inclusion of the financial leverage variables in addition to the term to maturity of the debt (measured in four consecutive time bands: up to 3 years, 3–5 years, 5–10 years and more than 10 years) and the volatility of the firm’s assets⁄equity (VOL; theVOL is annualized and mean centred).We present summary information on these additional explanatory variables in Table 2. From the data, we note that the average firm in the sample has more long-term debt than short-term debt as a proportion of their total assets. Additionally, the average firm in the sample has a positive growth rate, GR and a positive return on investment, ROI.

4. Model specification

As noted in the previous section, there are two broad categories of models that attempt to measure credit risk: traditional and structural models. Traditional models use the tools of fundamental analysis to ascertain if a company exhibits certain characteristics that raise the default probability.

These models examine factors such as cash flow adequacy, asset quality, earning performance and capital adequacy, drawing a small set of accounting variables, financial ratios and other information into a quantitative score. In some cases this score can literally be viewed as the probability of default, whereas in others it is used as some sort of a classification system. Early work was based on multivariate linear discriminate analysis (e.g. Altman 1968). More recent work use logit and probit models and include Cantor and Packer (1996), Blume, Lim, and MacKinlay (1998) and Pottier and Sommer (1999).

Structural models build upon the contingent claims framework developed by Merton (1974). Merton expresses a firm's risk neutral default probability and hence the spread on the debt that it issues, as a function of three primary variables namely: leverage, equity volatility8 and the time to maturity of the debt. The empirical performance of the Merton model has been a topic of considerable debate and refinements to the basic model suggested. Cardinale (2006) summarizes these refinements but notes that broad consistency emerges with regard to, for example, the identified relationship between credit spread and leverage. The empirical validity of the Merton framework is, however, emphasized by the fact that it underlies Moody'sKMVdefault probability model, which is a market leader.9

Benos and Papanastasopoulos (2007) and Demirovic and Thomas (2007), among others, find that application of the structural and traditional models need not necessarily be thought of as mutually exclusive. These researchers argue that a hybrid approach can 'enrich the default metric from a Merton type model'and therefore accounting variables can be 'incrementally informative to market-based measures'. As a consequence, we draw from both traditional and structural models in the derivation of testable propositions, see Equation (1).

The initial specification that was fitted to the data is as follows:

$$\begin{aligned}\mathrm{Log}(\mathrm{OAS}_{it}) = {} & \beta 0 + \beta 1\,\mathrm{PR}_{it} + \beta 2\,\mathrm{LTLEV}_{it} + \beta 3\,\mathrm{STLEV}_{it} + \beta 4\,\mathrm{VOL}_{it} \\ & + \beta 5\,\mathrm{GR}_{it} + \beta 6\,\mathrm{FS}_{it} + \beta 7\,\mathrm{ROI}_{it} + \beta 8\,\mathrm{DUR2}_{it} + \beta 9\,\mathrm{DUR3}_{it} \\ & + \beta 10\,\mathrm{DUR4}_{it} + \beta 11\,\mathrm{WAVE2003}_{it} + \beta 12\,\mathrm{WAVE2004}_{it} \\ & + \beta 13\,\mathrm{WAVE2005}_{it} + \beta 14\,\mathrm{WAVE2006}_{it} + \sum_{j=1}^{n} \gamma_j\,\mathrm{SIC}_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

Log(OAS_{it}) represents the natural logarithm of OAS on bond *i* at time *t*. $\mathrm{PR}_{it}$is the defined benefit pension risk (variously defined) of the firm who issues bond *i* at time *t*. $\mathrm{LTLEV}_{it}$and STLEV_{it} represent long- and short-term leverage. VOL_{it}, GR_{it}, $\mathrm{FS}_{it}$and $\mathrm{ROI}_{it}$are equityvolatility, growth rate, firm size and return on investment respectively. DUR are dummies to control the four duration bands. $\mathrm{SIC}_{it}$is also a dummy variable which is used to represent the two digit Standard Industrial Classification (SIC) code for the firm issuing bond *i* at time *t*. The SIC code dummies are used to control the fixed effects at the industry level. Analysis of regression diagnostics indicated that several two digit SIC codes dominate the sample. This causes excessive collinearity between the SIC dummies, which consequently inflates the variance estimates of the coefficients in the study. One solution is to reduce the number of dummies and as a result increase the number of firms in each category. This in practice is achieved by using two digit SIC codes for those industries which account for more than 4% of the sample, and one digit SIC codes otherwise. This reduces the variance inflation factors to an acceptable level below 10. Wave dummy variables control aggregate effects suspected to be fixed in the time dimension. As such, the specification represents a between-effects panel estimator.

Equation (1) performs the analysis assuming that the pension–credit risk relationship is uniform across the countries in the sample. Such an assumption is questionable because there are country-specific differences in pension protection provisions, accounting standards, disclosure requirements and actuarial modelling techniques. If this is the case it may imply that there are significant cross country variation in the magnitude of the pension risk coefficients. To test for country-specific effects, Equation (1) has been adapted to include interaction terms between the country dummies and the pension risk measure. In terms of assigning the country dummies, five countries dominated the sample thereby making collinearity a problem. Therefore, as with the SIC groups, if a country represented more than 4% of the overall sample, it remained as a distinct country group. If not it was grouped in a category entitled 'Other'. This led to distinct groups for France, Germany, the Netherlands, the UK and the US. CDUM_{it} represents the country dummy variable for the company that issues bond *i* at time *t*. The adjusted specification is as follows:

$$\begin{aligned}\mathrm{Log}(\mathrm{OAS}_{it}) = {} & \beta 0 + \beta 2\,\mathrm{LTLEV}_{it} + \beta 3\,\mathrm{STLEV}_{it} + \beta 4\,\mathrm{VOL}_{it} \\ & + \beta 5\,\mathrm{GR}_{it} + \beta 6\,\mathrm{FS}_{it} + \beta 7\,\mathrm{ROI}_{it} + \beta 8\,\mathrm{DUR2}_{it} + \beta 9\,\mathrm{DUR3}_{it} \\ & + \beta 10\,\mathrm{DUR4}_{it} + \beta 11\,\mathrm{WAVE2003}_{it} + \beta 12\,\mathrm{WAVE2004}_{it} \\ & + \beta 13\,\mathrm{WAVE2005}_{it} + \beta 14\,\mathrm{WAVE2006}_{it} + \sum_{j=1}^{n} \mathrm{SIC}_{it} \\ & + \sum_{k=1}^{m} \mathrm{CDUM}_{it} + \sum_{k=1}^{m} \theta_k (\mathrm{CDUM}_{it} \times \mathrm{PR}_{it}) + \varepsilon_{it} \qquad (2)\end{aligned}$$

In Equation (2), the original pension risk variable (PR_{it}) is dropped from the specification. This is undertaken to avoid perfect multi-collinearity with the pension risk interaction variables ($\mathrm{CDUM}_{it} \times \mathrm{PR}_{it}$). In this study, we have included interactions for all countries. Some researchers prefer to include the original pension risk measure and $n-1$ interaction terms, where *n* is the number of countries. However, this approach requires that in order to analyse the coefficients one must do so in reference to the base category (i.e. the country that is dropped). This is an inconvenience when one is dealing with many countries in a sample. Dropping the original pension risk measure and including interactions for all countries is referred to as the ‘partition approach’ and in this multi-country specification is more intuitively appealing.[10]

5. Empirical findings

A correlation matrix of a selection of variables used in the specifications is presented in Table 3. We note that, in general, the various definitions of the pension risk measure are highly positively correlated with each other, the STLEV and LTLEV variables are negatively correlated and there is quite a high correlation between FS and several other explanatory variables. All variance inflation factors fall below the cut-off point of 10.0, therefore variance estimates are efficient and multi-collinearity is not an issue.

In Table 4, the empirical results are presented in Equation (1). We present estimates for four models, which differ depending upon the definition of pension risk utilized. Coefficient estimates, standard errors and t -statistics are detailed. The use of a log linear specification ensures that the regression residuals more closely approximate a normal distribution. This was confirmed by approximating normal plots of kernel density functions for the residuals in each of the four models.[11]

Across all four specifications, R-squared is approximately 47% and all specifications pass the F test of joint significance. The key variable of interest in Table 4 is that of pension risk. The coefficient estimates on this variable are positive with three of the four significant at acceptable levels. This implies that the bond market (via the OAS on corporate debt) prices the risk of the defined benefit pension plan variously measured. This finding is consistent with the corporate financial perspective and agrees with the findings of, for example, Carroll and Niehaus (1998) and Cardinale (2006). Of the various pension risk facets, BS4 is most aggressively priced, while BS2 is not priced. A coefficient of 0.39 on BS4 implies that one-tenth of a unit[12] increase in the ratio of the defined benefit pension deficit to total assets increases the credit spread by $e^{0.3888/10} - 1 = 3.96\%$. In comparison, one-tenth of a unit increase in the ratio of pension liabilities to total assets (BS1) increases the credit spread by roughly $e^{0.1769/10} - 1 = 1.78\%$. That the market reacts more aggressively to unfunded liabilities as opposed to absolute liabilities is no surprise. In addition, the coefficient on BS3 is highly significant and implies that one-tenth of a unit increase in the ratio of the pension deficit to shareholder equity increases the credit spread by roughly $e^{0.07650/10} - 1 = 0.77\%$.

In Table 4, a range of control variables has also been introduced. Only two variables prove unimportant: GR and STLEV. It is interesting to note that while STLEV is insignificant, the LTLEV variable proves significant in all cases. This finding is supported elsewhere in the literature by Blume, Lim, and MacKinlay (1998) and Cardinale (2006), all documenting that LTLEV rather than STLEV is a predictor of credit risk. It is also interesting to note that the coefficients on LTLEV are sizeable and suggest that one-tenth of a unit increase in the ratio of long-term debt to total assets can increase the credit spread by as much as $e0.7788/10 - 1 = 8.10\%$ to $e0.8510/10 - 1 = 8.88\%$.

The specifications also show that there is a significant term structure effect in the corporate spreads. The coefficients on the duration bands increase as the time of maturity increases. This is an expected finding as the debt holder is exposed to risk over a longer period on purchasing bonds of longer maturities, therefore he must be compensated by a maturity-related risk premium. The wave dummies capture variation due to aggregate factors and are significant across specifications.

All coefficient estimates are lower than that of the base (omitted) dummy corresponding to 2002, which implies that post-2002 companies had lower spreads on the debt they issued. Of the years in which spreads were observed, they were smallest in 2004. The coefficient estimates on both FS and ROI are in each case negative and significant. This implies that larger firms with a higher ROI have a lower credit spread on the corporate debt that they issue. This is expected as firms with better operating performance are more likely to be able to service future debt claims. In addition, larger firms offer more security to debt holders in the event of bankruptcy. Finally,VOL is positive and significant. This is in keeping with the empirical findings of structural models of credit risk and is often overlooked in traditional accounting ratio-based models.

In Table 5, we present the results for reworked specifications in which we control differential pension–credit risk relationships between countries that are addressed by including interaction terms between the country dummies and the pension risk measure. Individual countries are analysed where they represent more than 4% of the overall sample resulting in coefficient estimates for France, Germany, the Netherlands, the UK and the US. Remaining countries are categorised under ‘Other’.

The total number of bonds (1828) in the cross country analysis (Table 5) is less than the number of bonds (1907) used in the original analysis (Table 4). This is due to the fact that there were quite a few off-shore issuer countries (e.g. Bermuda, the Cayman Islands and the Dutch Antilles) and were omitted from the sample to avoid wrongly including bonds ultimately issued by firms in larger countries in a smaller subgroup. Should this off-shore country be a haven for firms issuing debt, its category may then contain bonds ultimately issued by companies in more than one country.

Compared to the original specification, the extended specification results in a slight explanatory improvement. The *R*-squared values increase and now range from 50 to 55%. All specifications pass the *F* test of joint significance. The sign, magnitude and significance of the variables included as controls are very much in line with those detailed in Table 4 and therefore analysis of their marginal effects remains as earlier.

Of the countries examined, it appears that the pension–credit risk relation is significant in Germany, the US and the category ‘Other’. Traces of the relationship are found in the UK with the BS3 specification, but no significant relation is found in either France or the Netherlands. In both

Germany and the US, where the relationship is significant across all specifications, once again the market most aggressively prices BS4 (defined benefit pension deficit/total assets). In the US, one-tenth of a unit increase in the ratio of unfunded pension liabilities to total assets increases corporate credit spreads by roughly $e^{5.8375/10} - 1 = 79\%$. An identical pension risk increase in Germany increases credit spreads by roughly $e^{2.0278/10} - 1 = 22\%$. By comparison, one-tenth of a unit increase in the ratio of defined benefit pension liabilities to total assets (BS1) causes a credit spread increase of 16 and 11% in the US and Germany, respectively. The UK debt market prices pension risk BS3, i.e. deficit as a proportion of shareholder equity. One-tenth of a unit increase in this ratio increases the spreads of UK companies by 0.26% much lower than that of their US and German counterparts where this amount is 6.20 and 5.17%, respectively.

The pension–credit risk relationship is clearly not uniform across countries. This raises the question why might this be so? One argument might be that there are sophistication differences between markets that may result in differential capacities to price risk. In the context of this analysis, which identifies the highly developed financial markets of the US and the UK at different ends of the pension risk pricing spectrum, we would suggest that market sophistication is not an explanation. Earlier in the analysis we identified informational frictions. For example, financial reporting of pensions has been somewhat opaque with studies demonstrating that more transparent accounting standards negatively impact on the valuation of companies running pension plan deficits. There is also a lack of consistency of actuarial assumptions utilized in the calculation of pension plan funding particularly with respect to the discount rate, inflation rate, salary increases, return on equity and mortality rates. In addition, the role of a pension benefit guarantee fund, as guarantor of pension benefits, may cloud the relationship between the risk of the pension plan and market risk. It is in these informational frictions that we may find an explanation for the intercountry differential capacities to price pension risk. The implication being that these frictions differ across countries. While we do not seek to empirically attribute the inter-country differences in the pricing of pension risk to specific informational frictions, it is perhaps informative at this juncture to briefly highlight why some of these factors may be of potential importance.

If we consider accounting disclosure, the primary standards in Europe are IAS19 and FRS17 with, for example, FRS17 issued in 2000 in the UK as an attempt to ensure that financial statements reflect at fair value the assets and liabilities arising from an employer's retirement benefit obligations in the accounting periods in which they arise. The primary standard in the US is FAS87. The latter has attracted criticism with Soroosh and Espahbodi (2007) stating that '[under FAS87] the users of the financial statements have to plough through the footnotes to gain even a limited understanding of the impact of [pension] obligations'. Consequently, standard FAS158 was introduced in September 2006 closely mirroring the FRS17 requirements with respect to pension reporting. This suggests that pension disclosure was more transparent in the UK and Europe relative to the US. One line of argument might then be that the opacity in connection with US pension accounting disclosures resulted in investors in US firms being unable to properly gauge the risk posed by a defined benefit scheme. As a consequence, investors may require an additional risk premium to compensate for uncertainty surrounding the funded status of the scheme.

Actuarial valuation of pension scheme liabilities are based on deterministic assumptions regarding scheme attributes such as the discount rate, inflation rate, salary increases, return on equity and mortality rates. Not only are there pronounced differences across countries, but there is also an enormous unexplained variation in the results of actuarial valuations to determine pension scheme liabilities within countries. For example, PriceWaterhouse Coopers (2007) in a survey of 90 UK pension schemes document that common variations in the actuarial assumptions utilized can mean a swing of as much as an extra 25% either way in the calculated liabilities without apparent justification. They state that assumptions used to calculate liabilities should be based on the particular circumstances of the scheme and its sponsoring employer, but in reality they appear to be chosen more randomly'. Given the country-specific nature of demographic and certain economic assumptions, it could reasonably be argued that this translates into a variation as to how pension risk is priced internationally.

Inter-country differences in the pricing relationship could also arguably be due to the availability/operational sophistication of pension benefit guarantee schemes.Aproper functioning protection mechanism provides credible underwrite to the pension promise and in consequence can be expected to cloud the pension risk: credit risk relationship. Stewart (2007) contrasts schemes that are poorly designed such as that in the US with others that have superior design features such as the UK scheme. Those schemes that are not appropriately designed, encourage moral hazard, lack credibility and therefore in these countries the relationship between pension–credit risk may be more visible. In the case of the US Pension Benefit Guarantee Corporation (PBGC) criticisms have been voiced for its exposure to political interference and because premiums do not take into account the probability of participant bankruptcy, the composition of neither the firm's pension ,assets nor any asset liability mismatch. In contrast, the UK Pension Protection Fund (PPF), while loosely based on the PBGC is not subject to political interference, is self-financing, and the board of the PPF have freedom to determine the levy structure. In addition, the PPF levy (premium) features a risk factor element linked to the level of underfunding, investment strategy and the sponsor's credit rating.

6. Concluding comments

This paper examined the link between credit risk and pension liabilities using an econometric specification, which builds upon traditional accounting-based ratio models and market-based structural models of credit spreads. Traditional and structural variables were supplemented with variables designed to reflect the risk of a company's defined benefit pension plan. The empirical test was carried out using corporate bonds denominated in Euro, which encompass the US and European data largely for the period 2002–2006. The initial model revealed that defined benefit pension risk, variously measured, is a significant determinant of the OAS on corporate debt. This lends support to the view that debt markets are informationally efficient with regard to pension disclosures. Additionally, the analysis justifies the corporate financial perspective regarding the treatment of pension assets and liabilities. Our initial analysis also suggested that unfunded pension liabilities were not priced as aggressively as traditional leverage and this contrasts with the work of Cardinale (2006). A term structure effect was also noted. This is consistent with debt holders requiring a maturity-related risk premium as they are exposed to risk over a longer period when purchasing longer dated bonds.

An extended model was then formulated to permit closer examination of the pension–credit risk relationship by country with the implicit assumption being that heterogeneity exists. The empirical results revealed that the pension–credit risk relation is most prominent in the US and Germany, partially evident in the UK and not evident in France and the Netherlands. Additionally, in the US and Germany, unfunded pension liabilities are priced much more aggressively than traditional leverage by factors of 10 and 3, respectively. One implication of this finding is that for firms in the US and Germany running pension deficits, the preferred solution from a cost perspective, would be to borrow to finance the pension deficit.

In an attempt to explain why heterogeneity emerges in the pension–credit risk relation, we consider inter-country differences in accounting disclosure, actuarial assumptions and pension protection mechanisms. In this paper, we do not empirically test the role played by these factors which could be perceived as a limitation of the study. As part of our future research agenda, we therefore propose to undertake a firm-based inter-country event-study specifically focusing on changes in accounting disclosure and the pension protection premium. The event-study method will analyse the yield spread response of corporate bonds in an observation window spanning different periods pre and post the event under investigation. Abnormal excess returns will be calculated and assessed after correcting yield spreads in a market model that relates the corporate-specific yield to the appropriate benchmark (in our case, IBOXXEuro Corporate Index).

In addition a further extension of our research agenda will be an investigation of the implications of pension risk in the rapidly expanding Credit Default Swap market.

Notes

1. The media has latched onto the term 'the Perfect Storm' to describe the funding crisis. The idea behind this term is that post-2001 a combination of falling equity markets and declining interest rates resulted in a rapid deterioration in funding positions.
2. Lane, Clark, and Peacock (2008) report that deficits are on the rise again as the subprime mortgage crisis has caused deterioration in funding positions.
3. Cotter, Blake, and Dowd (2007) present an interesting overview of the financial risks faced by the UK PPF. Also considered is the experience with other government-sponsored insurance schemes such as the US Pension Benefit Guaranty Corporation. The authors conclude that the PPF will live under the permanent risk of insolvency as a consequence of the moral hazard, adverse selection and, especially, systemic risks that it faces.
4. Some non-European firms issue debt denominated in Euro therefore are represented as part of this index
5. In the extreme, Black (2006) and Tepper (1981) further point out that if the pension fund is invested in more heavily taxed assets such as bonds, the corporation should fund its pension plan to the maximum amount allowed by the tax authority in order to maximize the value of the tax shelter to the shareholders.
6. In order to discourage the moral hazard associated with the pension put option, pension benefit guarantee schemes used risk-based premiums, supervision and differential levels of support.
7. Carroll and Niehaus (1998) cite the mandated sharing of excess pension assets as the primary reason for the asymmetry. While the sponsoring firm has an obligation to cover any funding shortfall, a funding surplus must be partially shared with members of the scheme. Correspondingly, scheme members are exposed to upside return but no downside risk.
8. The purest form of the Merton model uses asset volatility as an explanatory variable; however, Jones, Mason, and Rosenfeld (1984) show that because the equity value is a function of the asset value, one can apply Ito's Lemma to determine the instantaneous volatility of the equity from the asset volatility.
9. Bohn, Arora, and Korablev (2005) argue that KMV–Merton models capture all the information in traditional agency ratings and well known accounting variables, while Wang and Suo (2006) shows that KMV–Merton probabilities have significant predictive power in a model of default probabilities over time.
10. For more information on the choice between the base and partition approach seeYip and Tsang (2007).
11. The kernel density functions are available from the authors on request.
12. Standard convention in analysing the coefficients of a log-linear model observes the resultant percentage change in the dependent variable from a unit change in the independent variable. The independent variables in this study are financial ratios and quite often the denominator is substantially larger than the numerator and consequently the average values of most of the independent variables are of the magnitude of tenths of units. Therefore, it is more intuitively appealing from an economic point of view to observe the marginal effect of one-tenth of a unit change in the independent variable on the dependent variable. One-tenth of a unit shifts in this case represent significant movements in the independent variables, where unit shifts would be highly unlikely in economic terms.

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Tables

Table 1. Total observations by country and time.

Issuer country	2006	2005	2004	2003	2002	All years	Total (%)
Australia	9	9	6	4	0	28	1.47
Belgium	4	3	2	1	0	10	0.52
Canada	3	2	3	3	3	14	0.73
Denmark	4	6	7	6	2	25	1.31
Finland	9	8	3	4	1	25	1.31
France	81	77	37	24	13	232	12.17
Germany	33	27	23	22	14	119	6.24
Ireland	15	10	8	4	1	38	1.99
Italy	13	11	0	0	0	24	1.26
Japan	7	6	5	1	1	20	1.05
Luxembourg	19	14	10	6	1	50	2.62
Netherlands	120	119	93	85	66	483	25.33
Portugal	2	2	2	2	2	10	0.52
Spain	5	3	0	0	0	8	0.42
Sweden	12	12	10	5	0	39	2.05
UK	97	91	74	64	21	347	18.20
USA	106	76	68	70	36	356	18.67
Residual*	25	22	16	10	6	79	4.14
Grand total	564	498	367	311	167	1907	100
Total (%)	29.58	26.11	19.24	16.31	8.76	100	–

*Note: Residual countries include Austria, Bermuda, Cayman Islands, Guernsey, Iceland, The Dutch Antilles, Norway and Jersey.

Table 2. Summary statistics of variables used in the analysis.

Variable	**Obs**	**Mean**	**SD**	**Q1**	**Median**	**Q3**
OAS	1907	55.3802	33.9990	32.0000	46.0000	66.0000
Log(OAS)	1907	3.8501	0.5589	3.4657	3.8286	4.1897
BS1	1907	0.1136	0.1673	0.0125	0.0434	0.1667
BS2	1907	0.4095	0.6689	0.0400	0.1302	0.4852
BS3	1907	0.2231	0.6248	0.0202	0.0929	0.1915
BS4	1907	0.0290	0.0451	0.0014	0.0080	0.0433
LTLev	1907	0.2082	0.1367	0.0981	0.1900	0.2917
STLev	1907	0.1365	0.0998	0.0519	0.1135	0.2106
VOL	1907	25.6057	7.3812	20.6507	24.8405	28.8450
GR	1907	0.0314	0.0793	−0.0132	0.0231	0.0555
ROI	1907	0.0255	0.0455	0.0065	0.0141	0.0394
FS	1907	5.0546	0.7319	4.4432	5.0415	5.7663

Table 3. Correlation matrix of variables used in the analysis.

	Log(OAS)	**BS1**	**BS2**	**BS3**	**BS4**	**LTLEV**	**STLEV**	**VOL**	**GR**	**ROI**	**FS**
Log(OAS)	1.0000										
BS1	0.0984	1.0000									
BS2	0.0340	0.8171	1.0000								
BS3	0.1371	0.4151	0.2171	1.0000							
BS4	0.1083	0.6527	0.5385	0.4940	1.0000						
LTLev	0.2313	0.2816	−0.0137	0.2173	0.1968	1.0000					
STLev	−0.1395	−0.2993	−0.3941	−0.0802	−0.2727	−0.2217	1.0000				
VOL	0.1969	−0.1023	−0.0176	−0.0028	−0.0554	−0.1911	0.0205	1.0000			
GR	−0.1369	−0.2076	−0.1321	−0.1115	−0.1723	−0.1864	0.1192	−0.0215	1.0000		
ROI	−0.1129	0.3117	0.3243	0.0187	0.1548	0.0742	−0.2446	−0.2708	0.1191	1.0000	
FS	−0.2447	−0.4698	−0.4101	−0.1567	−0.4259	−0.4417	0.5458	0.1344	0.1878	−0.4122	1.0000

Table 4. The determinants of option adjusted spreads.

Coefficient	BS1	BS2	BS3	BS4
PR variables	0.1769***	0.01611	0.07650***	0.3888*
	0.0589	0.0153	0.0232	0.2308
	3.0050	1.0524	3.2926	1.6849
LTLEV	0.8121***	0.8510***	0.7788***	0.8431***
	0.1005	0.1029	0.0981	0.1012
	8.0783	8.2679	7.9369	8.3302
STLEV	−0.1988	−0.1782	−0.2230	−0.2038
	0.1454	0.1472	0.1447	0.1455
	−1.3677	−1.2108	−1.5411	−1.4007
VOL	0.01401***	0.01398***	0.01375***	0.01400***
	0.0016	0.0016	0.0016	0.0016
	8.8997	8.8635	8.4846	8.8956
GR	0.02803	0.003236	−0.007298	−0.004523
	0.1262	0.1272	0.1262	0.1262
	0.2221	0.0254	−0.0578	−0.0358
ROI	−1.3817***	−1.3223***	−1.2945***	−1.2777***
	0.2904	0.2892	0.2826	0.2824
	−4.7571	−4.5721	−4.5811	−4.5239

FS	−0.2304***	−0.2333***	−0.2336***	−0.2308***
	0.0236	0.0236	0.0236	0.0234
	−9.7600	−9.8803	−9.9069	−9.8627
DUR2	0.1658***	0.1636***	0.1686***	0.1638***
	0.0282	0.0282	0.0278	0.0282
	5.8888	5.8029	6.0639	5.8140
DUR3	0.5006***	0.4971***	0.5018***	0.4965***
	0.0252	0.0253	0.0250	0.0252
	19.8469	19.6765	20.1119	19.6890
DUR4	0.8651***	0.8630***	0.8633***	0.8618***
	0.0324	0.0325	0.0323	0.0325
	26.7158	26.5861	26.6971	26.5243
WAVE2003	−0.4792***	−0.4791***	−0.4807***	−0.4791***
	0.0483	0.0483	0.0474	0.0484
	−9.9126	−9.9101	−10.1333	−9.9067
WAVE2004	−0.6083***	−0.6094***	−0.5979***	−0.6086***
	0.0472	0.0473	0.0456	0.0472
	−12.8820	−12.8968	−13.1185	−12.8868

WAVE2005	−0.5835***	−0.5859***	−0.5732***	−0.5836***
	0.0481	0.0481	0.0465	0.0480
	−12.1413	−12.1892	−12.3249	−12.1542
WAVE2006	−0.3921***	−0.3963***	−0.3798***	−0.3921***
	0.0460	0.0460	0.0443	0.0460
	−8.5212	−8.6058	−8.5767	−8.5260
Constant	4.6366***	4.6587***	4.6630***	4.6430***
	0.1388	0.1389	0.1395	0.1374
	33.4149	33.5385	33.4373	33.7842
Observations	1907	1907	1907	1907
R-squared	0.4736	0.4720	0.4782	0.4725

Notes: SIC dummy estimates not reported due to large number. Robust standard errors reported. ***Significant at the 1% level, **significant at the 5% level and *significant at the 10% level.

Table 5. The determinants of option adjusted spreads with country-specific adjustment.

Coefficient	**BS1**	**BS2**	**BS3**	**BS4**
PR variation				
LTLEV	0.7377***	0.7843***	0.6220***	0.7812***
	0.1014	0.1049	0.0949	0.1029
	7.2772	7.4796	6.5550	7.5896
STLEV	0.1350	0.1320	0.1420	0.1060
	0.1547	0.1566	0.1489	0.1527
	0.8728	0.8427	0.9532	0.6942
VOL	0.01323***	0.01236***	0.01368***	0.01329***
	0.0017	0.0017	0.0017	0.0017
	7.7813	7.4273	8.2273	7.9290
GR	0.1873	0.1402	0.09245	0.07173
	0.1330	0.1350	0.1307	0.1317
	1.4086	1.0383	0.7074	0.5448
ROI	−1.5309***	−1.6053***	−1.5061***	−1.3629***
	0.2905	0.2973	0.2959	0.2954
	−5.2702	−5.3992	−5.0897	−4.6139

FS	−0.3299***	−0.3154***	−0.3210***	−0.2817***
	0.0299	0.0304	0.0296	0.0308
	−11.0226	−10.3746	−10.8376	−9.1562
DUR2	0.1879***	0.1794***	0.2072***	0.1966***
	0.0270	0.0274	0.0255	0.0268
	6.9538	6.5599	8.1345	7.3424
DUR3	0.5247***	0.5111***	0.5383***	0.5277***
	0.0245	0.0248	0.0235	0.0248
	21.4614	20.5719	22.8959	21.2779
DUR4	0.8781***	0.8644***	0.8851***	0.8822***
	0.0324	0.0323	0.0318	0.0325
	27.1359	26.7939	27.8045	27.1853
WAVE2003	−0.5003***	−0.4974***	−0.4361***	−0.4892***
	0.0460	0.0473	0.0426	0.0459
	−10.8821	−10.5080	−10.2475	−10.6626
WAVE2004	−0.6051***	−0.6120***	−0.5380***	−0.5997***
	0.0454	0.0466	0.0419	0.0450
	−13.3404	−13.1212	−12.8395	−13.3370

WAVE2005	−0.5783***	−0.5854***	−0.5062***	−0.5686***
	0.0469	0.0479	0.0433	0.0465
	−12.3278	−12.2162	−11.6927	−12.2184
WAVE2006	−0.3801***	−0.3928***	−0.3058***	−0.3700***
	0.0450	0.0460	0.0414	0.0448
	−8.4511	−8.5467	−7.3864	−8.2568
PRFRANCE	0.2694	0.01451	0.09596	0.3305
	0.4872	0.0717	0.2846	1.6956
	0.5530	0.2026	0.3371	0.1949
PRGERMANY	1.0135***	0.07716	0.5045***	2.0278***
	0.3789	0.0740	0.1202	0.6118
	2.6748	1.0422	4.1989	3.3145
PRNETHERLANDS	0.05623	0.004322	−0.02125	0.3420
	0.1019	0.0168	0.0349	0.3671
	0.5518	0.2570	−0.6087	0.9318
PRUK	−0.02222	−0.02285	0.02631***	−0.06310
	0.0797	0.0290	0.0087	0.4263
	−0.2788	−0.7877	3.0250	−0.1480

PRUS	1.5227***	0.1441**	0.6015***	5.8375***
	0.3827	0.0629	0.0725	1.7551
	3.9785	2.2912	8.2980	3.3261
PROTHER	0.8118***	0.2125***	−0.02188	0.5420
	0.2758	0.0610	0.0222	0.5272
	2.9438	3.4856	−0.9858	1.0281
Constant	4.9487***	4.9784***	4.7900***	4.6726***
	0.1792	0.1809	0.1835	0.1899
	27.6207	27.5180	26.1010	24.6017
Observations	1828	1828	1828	1828
R-squared	0.5143	0.5005	0.5477	0.5098

Notes: SIC and country dummy estimates not reported due to large number. Robust standard errors reported. ***Significant at the 1% level, **significant at the 5% level and *significant at the 10% level.